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IMPROVEMENTS RELATING TO SMOKE DETECTION APPARATUS

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(71) Applicant(s)
Vision Systems Limited

(54) Inventor(s)
Martin Terence Cole

(NON-CONVENTION. By one or more persons and/or a Company.)

Form 1.

34537/84 PG1,975

COMMONWEALTH OF AUSTRALIA

Patents Act 1952-1969 577555

APPLICATION FOR A PATENT

~~COMPLETE AFTER PROVISIONAL~~ SPECIFICATION No. 34537/84

(1) Here insert (in full) Name or Names of Applicant or Applicants, followed by Address (es).

I ~~We~~ (1) MARTIN TERENCE COLE
of 7 Loxwood Avenue, Keysborough
Victoria, Australia 3173

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 11·8·88

(2) Here insert Title of Invention.

hereby apply for the grant of a Patent for an invention entitled: (2)
"IMPROVEMENTS RELATING TO SMOKE DETECTION APPARATUS"

which is described in the accompanying PROVISIONAL ~~complete~~ specification.

My ~~Our~~ address for service is Messrs. Edwd. Waters & Sons, Patent Attorneys, 50 Queen Street, Melbourne, Victoria, Australia.

LODGED AT SUB-OFFICE 21 OCT 1983 Melbourne

DATED this 20th day of October 1983

MARTIN TERENCE COLE

By my Patent Attorneys
EDWD. WATERS & SONS

(3) Signature (s) of Applicant (s) or Seal of Company and Signatures of its Officers as prescribed by its Articles of Association.

(3) 30 — 562813 21 OCT 1983

By L.J. Dyson

Form 7

(NON-CONVENTION. One or more persons.)

COMMONWEALTH of AUSTRALIA

Patents Act 1952-1969

DECLARATION IN SUPPORT OF AN APPLICATION FOR A PATENT OR PATENT OF ADDITION

(1) Here insert (in full) Name of Applicant or Applicants.

In support of the Application made by(1)

MARTIN TERENCE COLE

(2) Here insert title of Invention.

for a Patent for an invention entitled:(2)

"IMPROVEMENTS RELATING TO SMOKE DETECTION APPARATUS"

I ~~We~~ (1) MARTIN TERENCE COLE

(3) Here insert (in full) Address or Addresses.

of(3) 7 Loxwood A_venue, Keysborough Victoria Australia, 3173

do solemnly and sincerely declare as follows:

1. I am ~~We are~~ the applicant for the patent.

2. I am ~~We are~~ the actual inventor of the invention.

~~or~~

~~2.~~

(4) Here insert full Name(s) and Address(es) of Actual Inventor(s) if other than Applicant.

~~the actual inventor of the invention, and the facts upon which~~ I am ~~We are~~ ~~entitled to make the application, are as follow:~~

~~I am We are the assignee of the said (5)~~

(5) Full Name of Actual Inventor or Inventors.

DECLARED at Keysborough

this Twenty First day of October 1983

(6) [signature]

(6) Signature

DOCUMENTS
LODGED WITH
THIS APPLICATION
ARE UNSUITABLE
FOR REPRODUCTION
AND MAY BE
INSPECTED AT THE
PATENT OFFICE A.C.T.

(12) PATENT ABRIDGMENT (11) Document No. AU-B-34537/84
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 577551

(54) Title
IMPROVEMENTS RELATING TO SMOKE DETECTION APPARATUS

(51)4 International Patent Classification
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(71) Applicant
MARTIN TERENCE COLE

(72) Inventor
MARTIN TERENCE COLE

(74) Attorney or Agent
EDWD. WATERS & SONS

(56) Prior Art Documents
31841/84 G08B 17/10, G02B 5/02
GB 1490867
GB 1278205

(57) Claim

1. Pollution measurement apparatus comprising:

sample chamber means within which pollution is to be measured;

flashing light means for producing flashes to illuminate the inside of said sample chamber means;

monitoring means for producing first electrical pulses proportional to the strength of the light flashes produced by said flashing light means;

sensing means for producing second electrical pulses proportional to the strength of light flashes leaving said sample chamber;

first peak-detector and sample-and-hold means responsive to said first electrical pulses for providing a steady first output signal which is proportional to the peak amplitude of the most recently occurring one of said first electrical pulses;

second peak-detector and sample-and-hold means responsive to said second electrical pulses for providing a steady second output signal which is proportional to the peak amplitude of the most recently occurring one of said second electrical pulses;

means responsive to said first and second output

signals, for providing a measurement signal which accurately indicates the amount of pollution within said sample chamber.

577551

Form 10

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-69

COMPLETE SPECIFICATION

(ORIGINAL)

Class Int. Class

Application Number: PG 1975
Lodged: 21st October, 1983

Complete Specification Lodged:
Accepted:
Published:

Priority :

Related Art :

34537/84.

Name of Applicant: MARTIN TERENCE COLE

Address of Applicant: 7 Loxwood Avenue, Keysborough, Victoria, Australia. 3173.

Actual Inventor: MARTIN TERENCE COLE

Address for Service: EDWD. WATERS & SONS,
50 QUEEN STREET, MELBOURNE, AUSTRALIA, 3000.

Complete Specification for the invention entitled:

"IMPROVEMENTS RELATING TO SMOKE DETECTION APPARATUS"

LODGED AT [illegible]
1 [illegible]
Melbourne

The following statement is a full description of this invention, including the best method of performing it known to : me

The present invention relates to optical air pollution monitoring apparatus and more specifically an early warning fire detection apparatus incorporating a light scatter detection technique.

Numerous lives and billions of dollars in buildings and contents are lost each year because of fire. Conventional early warning smoke detection devices have been proven insensitive to detection of some highly toxic fumes liberated from commonly used synthetic materials. It is critical that fire fighting units are alerted at the earliest possible moment of the outbreak of a fire and that the occupants of an endangered building be evacuated upon production of noxious fumes and fire.

It has been recognised by workers in the field that conventional means of early fire warning by ionization detectors have severe limitations. In fact even in fire situations where considerable smoke has been generated the detector has not been activated. Such delays may result in dangerously low escape times for building occupants or permit the development of a fire to a point where considerable damage is done; because of the delayed warning.

Some factors that influence the operating efficiency of an early warning system include:-

1. The effect of forced ventilation sometimes preventing smoke from reaching ceiling mounted detectors;
2. Partial or complete shielding of detectors by building components such as ceiling beams, and ducts;
3. The necessity to de-sensitize detector apparatus to minimise false alarms arising from normal work situations e.g. smoking of cigarettes.

The present invention has as its objective to provide apparatus for detection of air pollution and fires and the initiation of control measures at the earliest possible moment whilst minimising false alarms.

It is a further objective to provide apparatus suitable for a wide variety of applications for example commercial offices, homes, apartments, hotels, dormitories, hospitals and institutions, art galleries and museums, schools, laboratories, computer rooms, telephone exchanges, power stations, warehouses, ships and railway carriages, etc.

Smoke detectors of the general type to which the present invention relates are disclosed in Australian Patent Specfication Nos. 412479, 415158, 465213 and 482860. Specification No. 415158 utilises an intermittently operating light source whilst No. 412479 discloses the use of a pair of light carrying rods. Specification No. 465213 discloses the removal of air samples from an air space under surveillance to detect the presence of carbon monoxide. Specification No. 482860 discloses the use of a pair of air sampling chambers coupled to a light source and photomultiplier tubes.

Photomultiplier tube designs have incorporated two sampling chambers in order to provide two channels of operation, the outputs of which are balanced in an attempt to counteract the effects of ageing and temperature drift, and also to overcome flash tube light intensity variations. This is attempted by means of a summing amplifier, where one channel is connected to the inverting input, the other to the non-inverting input. The resultant output signal is the difference between the two channels. However, this mechanism in fact does nothing to reduce the problems, being based upon a fallacy:

let F = light intensity of flash
S = the proporion of light signal scattered from smoke particles
B = the proportion of background light signal (a constant fixed by geometry)
$C1$ = channel 1 output signal level
$C2$ = channel 2 output signal level

Smoke is introduced into the first chamber only, thus:

C1 = F(S+B)

C2 = F(B)

1) SUBTRACTION OF SIGNALS METHOD:

C1-C2 = F(S+B-B) = FS

which is directly dependent upon F but is independent of B, i.e., is sensitive to flash variation although background signals cancel (if matched).

2) DIVISION OF SIGNALS METHOD:

C1/C2 = F(S+B)/F(B) = 1+(S/B)

which is independent of F, that is, is insensitive to flash variation, but is dependent on B, (however B is a constant.)

Let B assume the typical value of 0.2

C1/C2 = 1+5S

Thus to obtain the correct reading for S:

S = ((C1/C2)-1)/5

which in practise requires: a) a divider circuit,
b) an offset of -1, and
c) an attentuation by a factor of 5.

Thus, it is clear there is no advantage in employing a summing amplifier approach, either in an attempt to overcome variations in flash intensity or light detector sensitivity. No advantages stem from a dual chamber device because equal performance is achieved with a single chamber.

The mechanical design of an air pollution detector such as the sampling tube, reflector and absorber means are disclosed in my co-pending Australian application Nos. 31841/84, 31842/84 and 31843/84 respectively filed 12th August 1983. Furthermore, a solid state anemometer suitable for use in measuring ventilation air flow and the like is disclosed in my co-pending application No. PG 4919/84 filed 9th May, 1984.

The present invention relates to the provision of improved electronic circuitry for use in air pollution detection.

As previously mentioned, known detectors such as that disclosed in specification No. 482,860 utilised photomultipliers.

The detector disclosed in Patent No. 482,860 utilized a photomultiplier tube to detect the extremely low levels of light scattered off low concentrations of airborne smoke. Solid-state detection was considered impossible at room temperatures and at economical cost. As a result of considerable research, solid state circuitry has been developed which appears to have overcome the problems inherent in photomultiplier tube technology. For example, such problems as an extraordinary (10:1) spread in sensitivity from device to device, fragility, ageing, degradation when exposed to bright light, and the need for a special high-voltage power supply of high stability have been met.

A solid-state detector cell requires a preamplifier of extremely low noise, requiring development of a state-of-the-art design. Therefore detector cell and Xenon flash noise became the dominant, though insignificant sources of noise. Temperature compensation is also required, to provide calibration accuracy spanning at least zero to fifty degrees Celsius.

Contending with a flash rise-time of 1 microsecond, the detector cell should be small to minimise capacitance. This however, reduces the 'photon capture area' compared with the photomultiplier tube and a focusing lens is employed, with associated mounting hardware. Close attention to the preamplifier design using pulse-amplifier techniques is partly responsible for the noise reduction in the detector of the present invention. Earthing is of course another critical factor, together with a suitable interference-shielding container. In addition, immunity to

power supply variations has required special attention. The preamplifier, detector cell, optics and housing is preferably supplied as a self-contained separately tested plug-in module.

There is provided according to the present invention a pollution measurement apparatus comprising:

sample chamber means within which pollution is to be measured;

flashing light means for producing flashes to illuminate the inside of said sample chamber means;

monitoring means for producing flashes to illuminate the inside of said sample chamber means;

monitoring means for producing first electrical pulses proportional to the strength of the light flashes produced by said flashing light means;

sensing means for producing second electrical pulses proportional to the strength of light flashes leaving said sampling chamber;

first peak-detector and sample-and-hold means responsive to said first electrical pulses for providing a steady first output signal which is proportional to the peak amplitude of the most recently occurring one of said first electrical pulses;

second peak-detector and sample-and-hold means responsive to said second electrical pulses for providing a steady second output signal which is proportional to the peak amplitude of the most recently occurring one of said second electrical pulses;

means, responsive to said first and second output signals, for providing a measurement signal which accurately indicates the amount of pollution within said sample chamber.

~~Conveniently, three alarm thresholds are set to levels to correspond with desired points on the meter scale, or bargraph display.~~

~~In a further aspect of the present invention there is provided a light sensing apparatus in a pollution detection apparatus including a flash light source, amplifier means for producing an output pulse of high amplitude in response to said light flash, means for detecting and storing the peak amplitude of said output pulse, means for monitoring the flash intensity of said flash light source, means for detecting and storing the peak amplitude of the monitor pulse, divider circuit means for receiving said output and monitor pulses and providing compensation and improving the accuracy of the signal in the detection apparatus.~~

The invention will be described in greater detail having reference to the accompanying diagrams in which:-

Figure 1 is a block diagram of a detector circuit according to the invention.

Figure 1A is a block diagram showing the alternative use of a micro processor in the detector circuit.

Figure 2 is a block diagram of a controller circuit including a bargraph display and air flow monitoring circuits.

Figure 3 is a diagram showing control card interconnections.

Figure 4 is a diagram of interconnection between a controller card and detector head.

Figure 5 is a diagram showing connections between a control unit and data buses.

Figure 6 is a diagram of the controller face with the bargraph and alarm connections.

Figure 7 is a sectional view of a controller card housing.

With reference to Figure 1 the detector circuit receives a signal from the solid state detector cell and pulse preamplifier circuit as is described in greater

detail in my co-pending patent application No. 31841/84 mentioned above. The signal passes to a pulse-amplifier producing an output pulse of high amplitude. Gain adjustment of the amplifier 2 provides adjustment of the signal to achieve calibration. A peak-detector 3 of high accuracy and having good linearity over a wide dynamic range and a single active sample-and-hold circuit 4 of particularly low leakage and also having good linearity over a wide dynamic range plus a summing amplifier 5 and transconductance amplifier 6 for providing a constant-current output drive. The calibration offset allows for offset of the effects of remnant background light (which is a fixed component) in the sampling chamber to the point where the signal is independent of the effects of background light.

The normal sampling rate of the monitored space is approximately 3 seconds however, D.C. stability is sufficient to allow optional sampling rates up to 30 seconds thus allowing extension of Xenon flash tube life to as long as 20 years (suitable for areas of relatively slow potential fire growth).

Referring to Figure 1A there is shown an alternative arrangement wherein the peak detector 3 and sample-and-hold circuit 4 is replaced by a micro-processor 30 programmed to receive and store the peak amplitude of an output pulse from said pulse amplifier. The microprocessor can be used for division of the signal from the monitor amplifier and provides the timing for the flash tube 8.

With reference to Figures 1 and 1A to improve production and testing of the apparatus all electronic circuitry, apart from the detector cell and the preamplifier module, is incorporated into a single printed circuit board.

Whereas it is customery to provide a regulated supply it is possible with the present invention circuitry to permit operation from an unregulated 24V DC supply which can include standby batteries (20-28V tolerance), in

conformity with most conventional fire alarm systems. Wide voltage tolerance provides for greater immunity to cabling voltage-drop. In view of the standby battery capacity requirement, circuitry is refined to reduce power consumption to 6 Watts. This further reduces cabling voltage-drop problems. The Xenon flash power supply provides the greatest opportunity for this power reduction, through increased efficiency, of a 400V inverter. To maximise consistency of flash brilliance, this supply is tightly regulated and temperature compensated.

Preferably the device includes a Xenon flash tube monitor 10 in the sampling chamber to calibrate or adjust for variations in flash intensity that may result from "flash noise", aging, or temperature. Accordingly, divider 12 provides compensation of the signal received from the monitor 10 and amplifier 11 thereby improving the accuracy of the signal in the detector circuit going to the control.

The divider 12 includes circuitry adapted to convert signals received from the detector 9 and monitor 10 to logarithins then to subtract said logarithins, reconverting the resultant signal by an anti logarithin circuit to a normal signal. Thus, the divider circuit will remove or compensate for flash intensity variation or temperature variations.

The alarm threshold of the air flow sensor 7a may be factory preset within the detector. However, it is preferable to provide an analog output of air flow, utilizing an identical output circuit to that used for smoke intensity (another transconductance amplifier). The constant-current output in both cases provides complete immunity to errors introduced by cabling losses, whilst a low impedance load followed by low-pass filtering and over-voltage protection within the control unit, overcomes interference induction. The alarm threshold can then be set conveniently in the control unit, to a flow rate consistent with the response time required for detection.

The voltage signal is converted to current by

convertor 6 to avoid the effects of losses in the line to the controller which may be at a remote station in the building. With reference to Figure 2 and Figure 6 the current signal from the detector is received and converted to voltage at 13. The controller includes a housing for up to eight (say) individual control cards 20 (Figure 3) each associated with a detector. The housing may be of extruded aluminium rail frame and side plate construction whereby it is adaptable to accommodate from one to eight control cards. Thus, where space is at a premium the size of the housing can be reduced by shortening the rails.

Originally the control unit provided four output relays namely: Alarm 1, Alarm 2, Alarm 3 and Fail. The Fail relay combined the functions of air flow failure and smoke detection failure. Preferably these two functions are split on the basis that they might require a differing response. A sixth relay is added to indicate that a test is being performed so that operation of any other relay can be ignored until completion of the test. According to the present invention it is proposed to transfer the six relays to a separate relay interface card 23 which can be driven by all controller cards using a ribbon-cable bus in a "daisy-chain" connection.

To minimise the number of electrical transitions beyond the control card for any given wire whilst maximising physical design flexibility, the housing frame accommodates a mixture of ribbon-cable 21 and printed-circuit edge connectors 22. This design also facilitates the replacement of any ribbon-cable for one of a different length or configuration, to suit unexpected situations that may arise in the field. Figures 3, 4 and 5 depict schematically the control card interconnections with the optional data bus and computer or micro processor (not shown) and a relay interface card 23.

Calibration and testing of the detector is simplified by adopting a full scale measurement of 5.5

milli-amps. An 0.5 milli-amp offset is used to assist in sensing signal loss caused by lamp failure, cable breakage etc. Each additional 0.5 mA represents an increment of 0.01% pollution e.g. smoke. Within the controller this is translated to one volt offset with one volt major scale divisions and eleven volt full scale. Beyond the failure-detection circuitry the inclusion of a summing amplifier permits subtraction of the one volt offset before presentation of the display and chart-recorder output such that 0-10 volts represents 0-0.10% smoke (0-1000 parts/million).

Calibration of the detector utilizing the known scattering-coefficients of suitable pure gases requires outputs such as 0.775 mA for Carbon Dioxide and 2.200 mA for Freon 12, whilst the sensitivity-test output was set to 4.5 mA.

The span of 0.5-5.5 mA was selected for low power consumption, however, the design is sufficiently flexible to allow the Detector and Controller according to the invention to be reconfigured to comply with the industrial controls standard of a 4-20 mA signalling current loop. Referring to figure 6 for each controller card 20 an individual LED bargraph display 30 showing smoke intensity is provided. Thus, from a distance, without the need for switch selection, the readings from all Detectors can be readily seen.

Utilizing the bargraph circuitry a gold plated programming pin 31 on a roving lead is coupled to each of the three alarm thresholds 32 providing a convenient and easily viewable means for setting the alarm levels.

As a fail-safe feature in the unlikely event that programming pins are left unplugged or broken, an override circuit ensures that the third alarm threshold automatically defaults to the full-scale smoke level. Timers for delaying the operation of each alarm, adjustable by means of potentiometers, are located immediately below

their relevant alarm lamp, and are accessible without removing the Controller card. Also located on the front of the Controller card are test buttons for detector sensitivity and detector failure. Timer adjustments and testing facilities are hidden and protected behind an escutcheon to prevent tampering.

A feature of the control unit is the provision of a switch-option to designate the first (left-most) Controller card and its associated Detector as the Reference channel.

Output from the first Controller is bussed to all other Controllers, with the degree of signal subtraction individually adjustable (0-100%).

This Reference Detector is adapted to measure the incoming air quality at the make-up air register of an air-conditioning system. To ensure that the Controller would respond only to the net gain in smoke from sources within the building, the output from the Reference Detector can be subtracted, partially or wholly. Even for large installations, only one Reference Detector would be required. An additional advantage of the reference channel is the ability to provide a separate "pollution alert" for computer areas and other "clean" environments.

Alternatively, the setting of alarm thresholds the operation of time delays and air flow detection can be implemented by a micro-processor by projecting a visual output such as a bargraph or numerical display. When a micro-processor is used in substitution for detectors and controller cards it is feasible to use digital signals methods such as those that conform to RS232 Standard for serial data transmission, as distinct from the analogue method of constant current signals.

The Controller uses both a red and a green lamp to indicate air flow with the addition of an adjustable timer to allow for short term reductions in air flow, which might result from normal air-handling control functions in the building (for example in the case of in-duct detection).

Matched to this is another pair of lamps for the "Fail" detection circuitry, with a similar timer. Particularly large, dual-element rectangular LED lamps have been developed with careful attention to uniform light diffusion, for all displays (17 lamps per Controller). This permitted escutcheon artwork information to be rear-lit by the lamps, for aesthetic appeal and to avoid ambiguity.

With the bargraph display, yellow LED lamps are used for each segment. The present invention has the adopted philosophy that any alarm condition should be indicated by a red lamp. Thus any red lamp seen from a distance would require attention, whether it proved to be one of the three smoke intensity thresholds, the Detector failure alarm or the air flow failure alarm. To enhance the feeling of urgency, these red lamps are made to flash. Operation of any one of these red lamps indicates the operation of its associated relay.

An optional version of the Controller card according to the present invention has been designed. This provides latching of the red alarm lamps and their associated relays, to account for transient conditions which might disappear before an attendant may arrive (especially in a multi-Detector installation). A toggle-switch is provided on each Controller card, to mount through the escutcheon. Such a switch is chosen for the obvious nature of its positions. In the "normal" position, all red lamps and their relays would be operable and could latch on. While in the "isolate" position, all red lamps and their relays would reset (unlatch) and would remain isolated (disabled), during which the "test" relay would operate (renamed the "isolate-test" relay). In either switch position the true conditions pertinent to the Detector remain clearly displayed because of the bargraph (with its clearly visible programming pins to indicate the alarm thresholds) and the green lamps (indicating the Detector and air flow were correct).

In an alternative form of the invention a data-bus "mother-board" is provided within the control unit to facilitate the connection of a computer, such as a separate building services monitoring computer which is enabled to scan each Controller card to obtain readings of smoke intensity and air flow. In this way it can monitor the entire alarm system and initiate appropriate actions. Its data-logging function permits the automatic compilation of statistics on typical ambient smoke levels and the result of simulated fires, such that alarm thresholds can be optimised. The alarm thresholds within the computer, can be altered at different times, typically selecting greater sensitivity during hours when a building is unoccupied. It can also activate a sensitivity test or a failure test for each Detector, in conformity with some prearranged schedule.

Subtraction of the reference signal may also be performed by the computer. This enables the time-related dilution/concentration factors to be taken into account on a zone-by-zone basis.

A capability for manual operation in the event of computer malfunction is considered an essential practical requirement, this transition being accomplished on a latching Controller card via the "normal/isolate" switch (i.e. manual system isolated while computer functioning.)

Also provided on the data-bus board is a ribbon-cable connector for all chart-recorder outputs. This facilitates connection to a data-logger, multi-pen recorder or to a selector switch.

CLAIMS

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Pollution measurement apparatus comprising:

sample chamber means within which pollution is to be measured;

flashing light means for producing flashes to illuminate the inside of said sample chamber means;

monitoring means for producing first electrical pulses proportional to the strength of the light flashes produced by said flashing light means;

sensing means for producing second electrical pulses proportional to the strength of light flashes leaving said sample chamber;

first peak-detector and sample-and-hold means responsive to said first electrical pulses for providing a steady first output signal which is proportional to the peak amplitude of the most recently occurring one of said first electrical pulses;

second peak-detector and sample-and-hold means responsive to said second electrical pulses for providing a steady second output signal which is proportional to the peak amplitude of the most recently occurring one of said second electrical pulses;

means responsive to said first and second output signals, for providing a measurement signal which accurately indicates the amount of pollution within said sample chamber.

2. The pollution measurement apparatus as claimed in claim 1, further comprising divider means adapted to compensate said measurement signal for flash intensity variations.

3. The pollution measurement apparatus of claim 2 comprising further:

algebraic summation means to combine one of said output signals with an adjustable calibration offset signal, to provide a measurement signal which is further compensated for zero offset by adjustment of said adjustable calibration offset signal.

4. The pollution measurement apparatus of claim 1 or 2 wherein said first and second peak-detector and sample-and-hold means comprise:

analog-to-digital conversion and microprocessor means, responsive to said sensing and said monitoring means, for producing said measurement signal.

5. The pollution measurement apparatus of claim 1 or 2 comprising:

a multiphase clock,

means for controlling the flashing of said light means, said first and second peak-detecting and sample-and-hold means under the timing control of said multiphase clock.

6. The pollution measurement apparatus of any one of the preceding claims comprising:

display means for visually displaying the value of said measurement signal on a bargraph in incremental steps;

programming means for tapping off selected bargraph segments to actuate corresponding alarm means, each alarm means set to be activated at the threshold indicated by the respective tapped segment.

7. The pollution measurement apparatus of claim 6 wherein said programming means comprise:

gold plated programming connecting pins on individual flexible roving leads for coupling to respective ones of said selected bargraph segments to thereby provide viewable indication of the level setting of the respective said alarm means.

8. The pollution measurement apparatus of claim 7 comprising further:

override circuit means for setting an alarm in event of the disconnection of the circuit of a programming pin.

9. The pollution measurement apparatus of claim 6 comprising further:

adjustable means to delay the operation of each alarm a predetermined interval of time.

10. Pollution measurement system comprising a plurality of pollution measurement apparatus as claimed in claim 6, each of said pollution measurement apparatus being associated with a respective controller card, a selected controller card being associated with a reference pollution measurement apparatus in a reference area for measuring the quality of incoming air to an area under surveillance, the measurement signal from said reference pollution measurement apparatus being at least partially subtracted from the measurement signal of each other pollution measurement apparatus, so that each said pollution measurement apparatus displays a measurement signal valve indicative of a net gain in pollution from sources within the surveillance area.

<u>DATED</u> this 16th day of June, 1988.

<u>MARTIN TERENCE COLE</u>

EDWD. WATERS & SONS,
Patent Attorneys
50 Queen Street
MELBOURNE. VIC. 3000
AUSTRALIA

LJD/PNF:EK(5.25)

DRAWINGS

19 10 84 34537

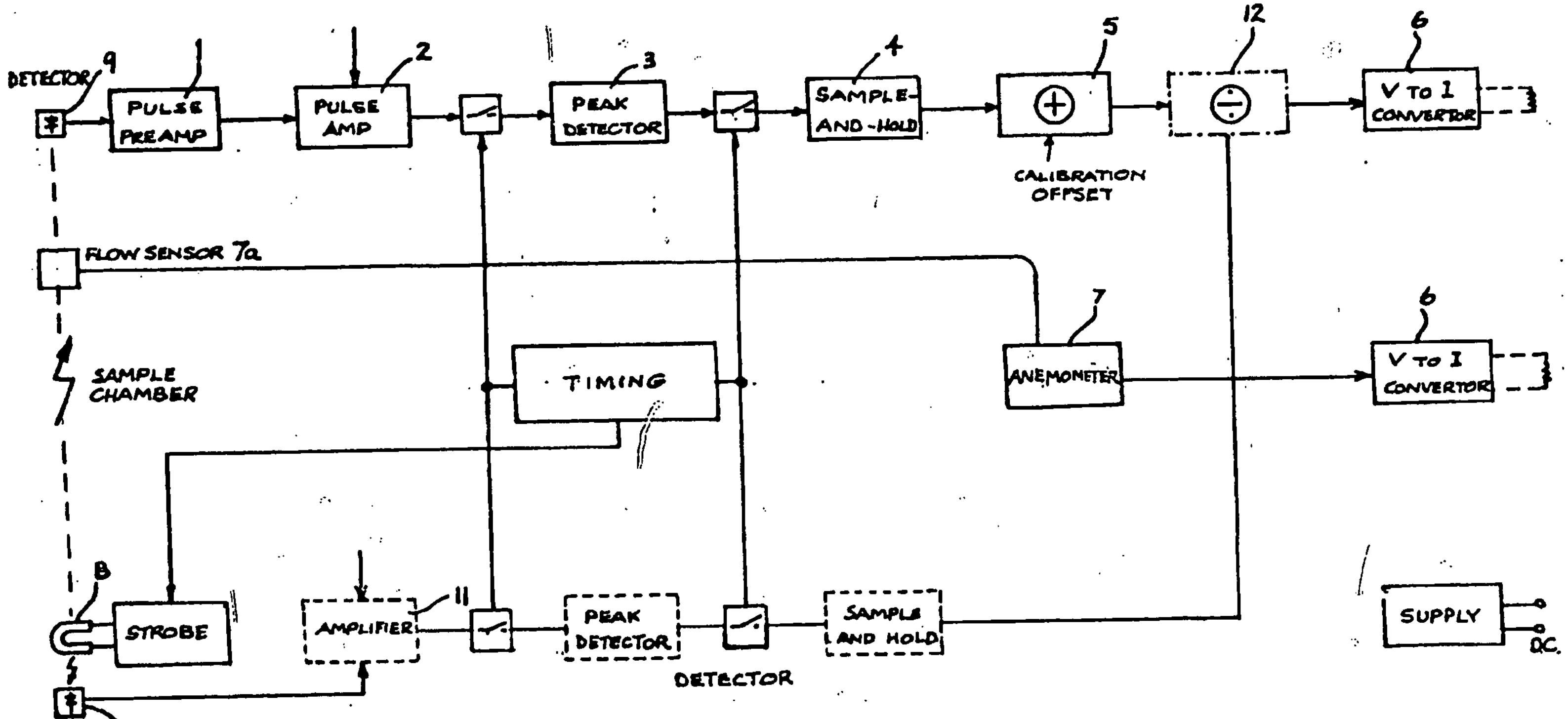


FIG. 1.

34.537/84

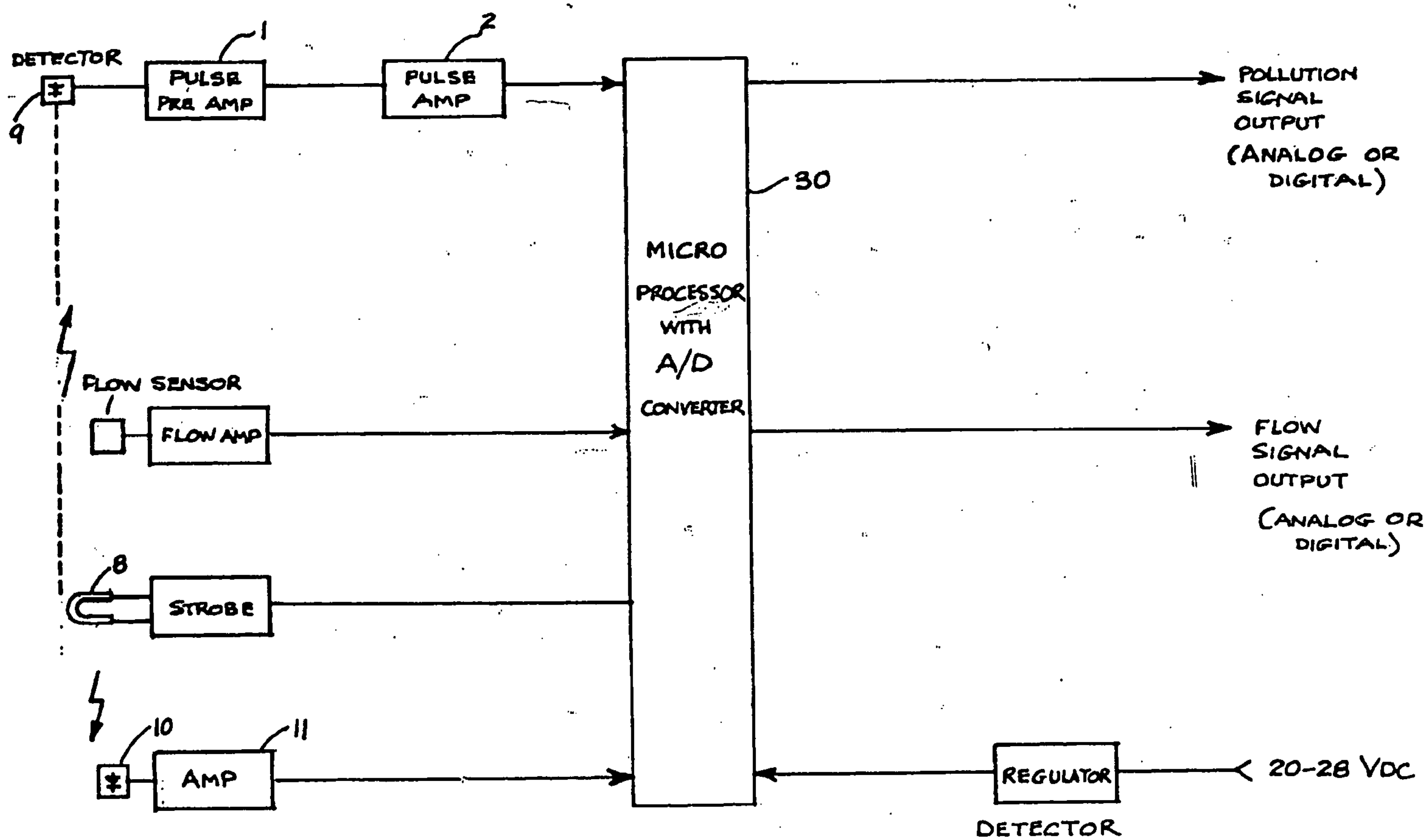


FIG. 1A.

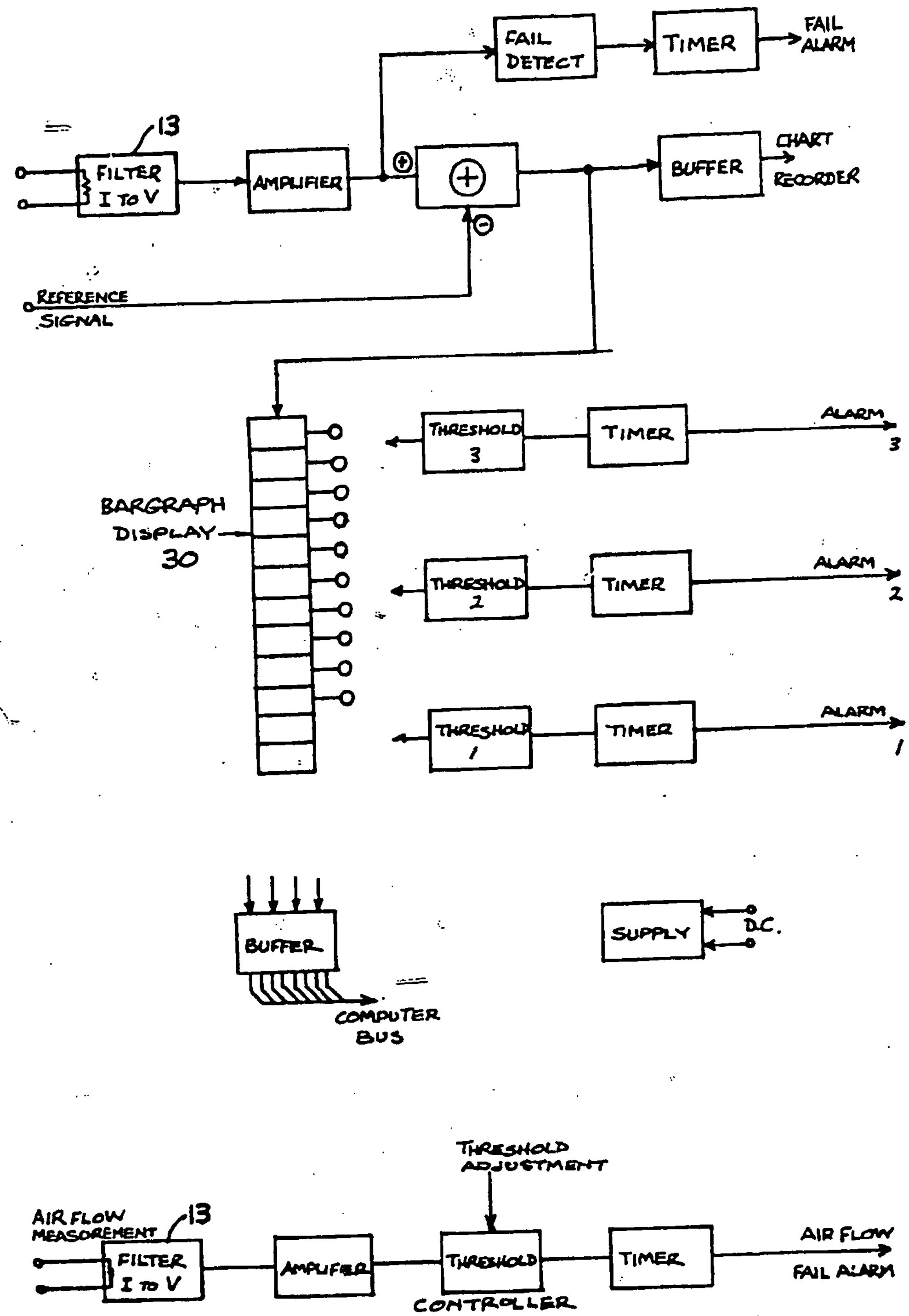
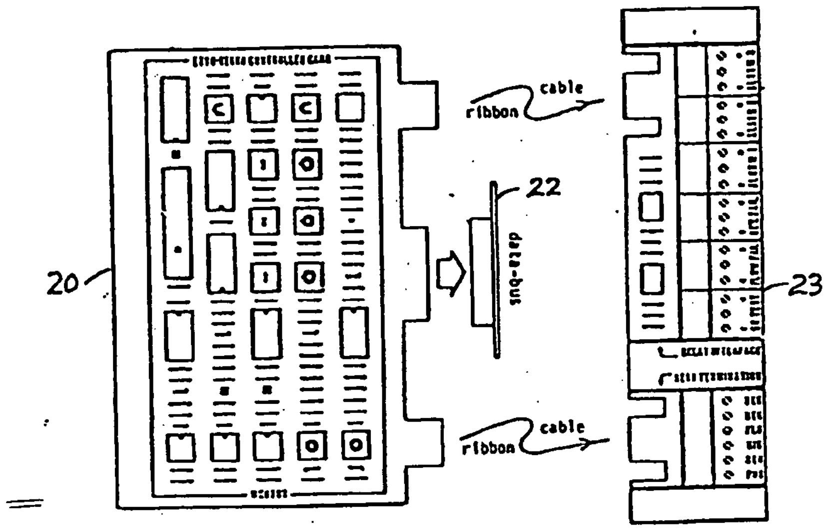
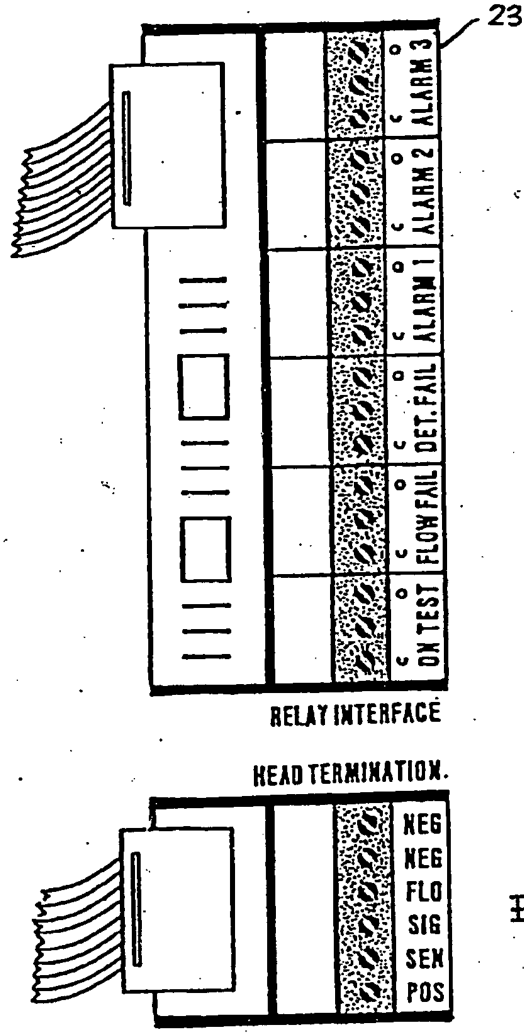

FAIL DETECT
TIMER
FAIL ALARM
13
FILTER I TO V
AMPLIFIER
BUFFER
CHART RECORDER
REFERENCE SIGNAL
BARGRAPH DISPLAY 30
THRESHOLD 3
TIMER
ALARM 3
THRESHOLD 2
TIMER
ALARM 2
THRESHOLD 1
TIMER
ALARM 1
BUFFER
COMPUTER BUS
SUPPLY
D.C.
THRESHOLD ADJUSTMENT
AIR FLOW MEASUREMENT
13
FILTER I TO V
AMPLIFIER
THRESHOLD
CONTROLLER
TIMER
AIR FLOW FAIL ALARM

FIG. 2.



20
22
23
ribbon cable
ribbon cable
data-bus

FIG.3.



23
ALARM 3
ALARM 2
ALARM 1
DET. FAIL
FLOW FAIL
ON TEST
RELAY INTERFACE
HEAD TERMINATION.
NEG
NEG
FLO
SIG
SEN
POS

FIG. 4.

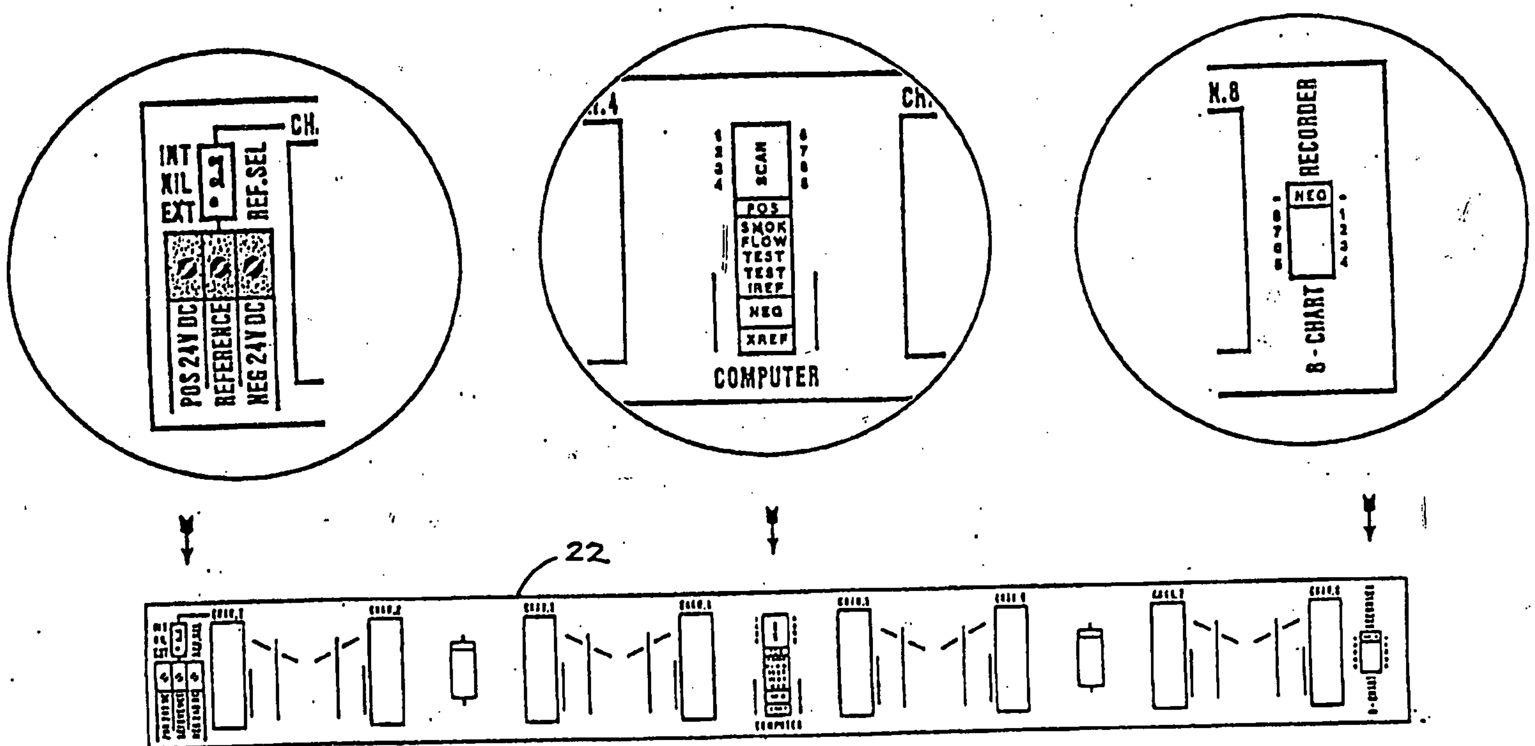

CH.
INT
XIL
EXT
REF.SEL
POS 24V DC
REFERENCE
NEG 24V DC
SCAN
POS
SMOK
FLOW
TEST
TEST
IREF
NEG
XREF
COMPUTER
CH.
RECORDER
NEG
8 - CHART
22

FIG. 5.

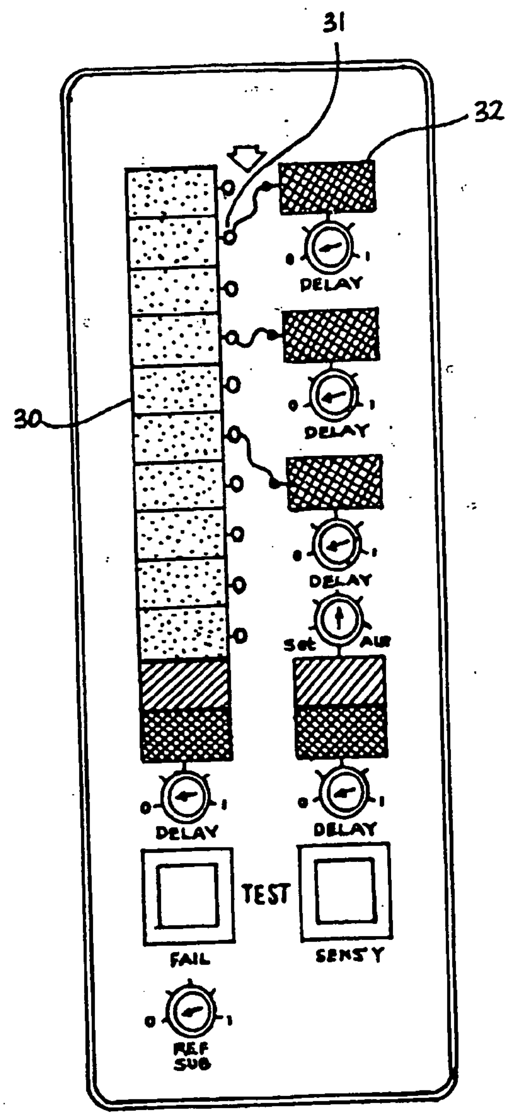

31
32
30
DELAY
DELAY
DELAY
Set
Alr
DELAY
DELAY
TEST
FAIL
SENS'Y
REF
SUB

FIG. 6.

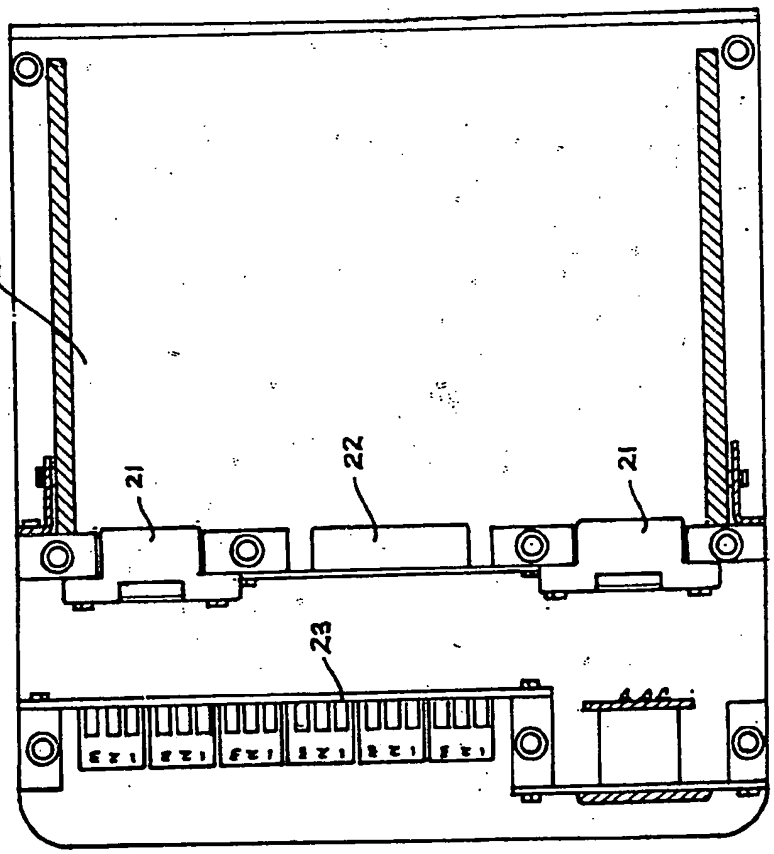


FIG. 7.